TORREYA

Vol. 36 September–October, 1936 No. 5

Pollen in Hayfever
Part 2

R. P. Wodehouse

If one wishes to discover which kinds of pollen are abundant in the air and likely to cause hayfever it is only necessary to expose a microscope slide with a small spot lightly coated with glycerine jelly to which has been added an appropriate dye such as basic fuchsin. After exposing for about 24 hours the slide is brought in, warmed gently and covered with a thin cover glass. Examination with the microscope will then show the pollen deeply stained, fully expanded, and properly imbedded in an excellent medium for their identification. If the microscope has a mechanical stage it is a simple matter to count all the different kinds of pollen encountered and so determine the relative abundance of each in the air.

For purposes of identification one should have a reference collection of the pollen of all the different kinds of anemophilous species of the region and as many as possible of the more abundant entomophilous species. Most of these have been described, illustrated, and keyed out in the author's book, "Pollen Grains,"[1] but there is no substitute for a good reference collection. The specimens should be mounted in glycerine jelly and stained with the same dye that is used for making the atmospheric pollen slides.

On atmospheric pollen slides grains of both entomophilous and anemophilous species will be found but the latter always greatly outnumber the former. The anemophilous species are naturally of the greater interest from a hayfever standpoint, but to the pollen morphologist they are distinctly less interesting because they are generally characterized by extreme sim-

[1] Pollen Grains. The McGraw-Hill Book Co. New York. 1935.

plicity. Like wind pollinated flowers they have suffered reductions in response to anemophily. The grains of the grasses which are all anemophilous are smooth and globular, ellipsoidal, or ovoidal. Those of all species are very much alike, differing mainly in size. They may always be recognized by their thin outer coat and single small germ pore slightly raised and provided with a small operculum. The grains of English plantain are somewhat similar but are provided with 7 to 14 pores and their outer coat is slightly mottled. The grains of Rugel's plantain are sometimes caught on pollen slides too, but may easily be distinguished by their rougher coat and fewer pores, 6 to 10 in Rugel's and 4 to 6 in common plantain. The pollen grains of birch are likewise smooth, generally provided with three pores arranged around the equator, each elevated above the surface so as to give the grain a triangular outline. The pollen grains of all the birch family are like this. These grains, though simple, are not primitive; they have achieved this simplicity by evolving away from the central basic forms of angiospermous pollen grains. In reverting to the primitive gymnospermous habit of anemophily they tend to assume in some respects the gymnospermous simplicity of form, yet they can nearly always be distinguished from them. We are reminded in this of the whales and porpoises; upon returning to their remotely ancestral aquatic habit they assumed in part the outward form of their fishy ancestors but retained all the more important anatomical features of their less remote mammalian ancestors.

The goldenrod pollen grain may be taken as an example of the basic form of those of the higher dicotyledons. It is a small globular body about 23μ in diameter with a thin elastic but unperforated inner coat and a thick semi-rigid outer coat, quite appropriately likened to the inner tube and outer casing of an automobile tire, and, like the latter, the outer coat of the pollen grains of different plants exhibit an enormous variety of sculpturing, which is extremely convenient in enabling one to tell which plant was responsible for their genesis. In the golden rod pollen grain the outer coat is covered with short but sharp-pointed conical spines. Since these grains are designed to be carried by insects it might be assumed that these are "non-skid" spines, so to speak, which help to keep the grains from slipping off the insects. This may be partly their function, but under the microscope they are seen to serve also the purpose of keeping properly distributed a relatively very thick layer of viscous semi-fluid oil with which these grains are provided. This is a matter of minute contours in relation to surface tension and finds its analogy in the fact that you must roughen with sandpaper a newly varnished surface before applying the second coat, or the new coat, while still fluid, will gather into droplets instead of remaining smooth and even. It is this enveloping layer of oil which serves to stick the grains to each other and to the insects which are to carry them; pollen grains lack the weight to make their spines or other sculpturing effective in preventing skidding.

Pollen grains are nearly always very susceptible to changes in moisture. So rapidly do they absorb moisture from their surroundings that it is difficult to accurately weigh a gram or two of most pollen in ordinary air. As the grains take up moisture they expand consequently they must be provided with some mechanism for accommodating such volume changes without prematurely rupturing the non-distensible outer coat. In the goldenrod pollen grain volume changes are accommodated by three meridionally arranged furrows. When such a grain is dry it is ellipsoidal in form with three deep longitudinal grooves, the delicate inner coat completely covered by the protective outer coat. This is the resting condition of the pollen grain. But as soon as it is quickened by the touch of a little moisture the furrows open, very much as the eye opens after sleep, and each furrow is seen to be crossed by a delicate membrane like the cornea of the eye, and in place of the pupil is a central opening, the germ pore, through which may protrude the germinal papilla, accounting for still further internal expansion of the grain. As the furrows expand the grain changes its shape from elongate ellipsoid to spheroid thereby greatly increasing its volume without materially affecting its linear dimensions.

The three-furrowed type of grain is by far the commonest among the higher dicotyledons, accounting for about two-thirds of all species, and may be regarded as the basic form from which all others are derived. The sculpturing varies with the genus, tribe or family. In most of the tribes of the composite family it is echinate like the goldenrod grain, but in the chicory tribe the surface is thrown into an elaborate system of ridges with the spines on their crests, as in the grains of dandelion. In the olive family the surface is covered with a beatuiful reticulate pattern, as in the grains of privet. In the holly the surface is pebbled. All possible modifications and combinations of these and many other sculpturings are found in association with the basic three-furrowed form of grain.

But not all dicotyledonous pollen grains have only three furrows. Some have 4, 6, 9, 12, 15 up to 30, and even sometimes more. As a rule these conform in arrangement to very definite geometrical patterns. For example, dahlia pollen grains always have six furrows arranged according to the edges of a tetrahedron. Those of the carpet weed (*Mollugo verticillata*) have twelve furrows arranged according to the edges of a cube, and the beautiful grains of the garden portulaca often have thirty furrows arranged according to the edges of a pentagonal dodecahedron. But this is a most exceptional kind of grain because as the number of furrows increases they must shorten, and this they do without losing much in width, thus becoming circular and coinciding in extent with their enclosed germ pores. There are whole families with pollen grains of this kind, provided with round holes instead of furrows, the plantains, the mallows, the four-o'clocks, most of the cucurbits, the amaranths, the chenopods, and many others. These we call pored grains in order to distinguish them from furrowed grains. These pores, of course, cannot function as furrows in accommodating changes in volume but the germinal papillae can be protruded and withdrawn, and in this way they accomplish the same end, making up in numbers their loss of mechanical action. Still other pollen grains have only one furrow, but these are not found among the higher dicotyledons; the one-furrowed grain is the sign of the gymnosperms, the lower dicotyledons, and most monocotyledons, all, in fact, except such Helobieae as the arrow-heads and water plantains which appear to be badly misplaced in our plant classifications for they show their strongest affinities with the crowfoot family among the dicotyledons. Thus the grains of such gymnosperms as the cycads and ginkgo are long and boat shaped with one long furrow reaching from end to end. Those of the dicotyledonous magnolias and peppers are almost exactly the same, so also are those of the lilies and some of the arums among the monocotyledons. The one-furrowed type of grain is immensely ancient, even older than the pollen grain itself, tracing its origin back to the Pteridosperms, and is even dimly foreshadowed in the spores of the ferns. The three-furrowed grain and its many-furrowed and many-pored derivatives are by comparison quite modern, appearing nowhere below the higher dicotyledons.

Pollen grains, like the plants themselves, are greatly modified by adaptation to their environment, but their environment is very much simpler than that of the plants. In fact all their environmental factors resolve themselves into just one, their mode of pollination. So, while grains which are decorated with spines and ridges and covered with a layer of sticky oil may be just right to be carried off by insects, they would never do if they are to be carried by wind. Such must freely separate from each other and must not stick to anything until they reach the stigma which is designed to catch them. And so it is that anemophilous grains must abandon their golden yellow layer of sticky oil and their beautiful sculptured patterns.

So far is this simplification carried that it is often difficult to even guess from their pollen grains to what entomophilous group of plants an anemophilous plant is related. For example the pollen grains of willows which are primarily insect pollinated have a rather thick outer coat bearing a beautiful reticulate pattern and covered with a thin layer of sticky oil, and are provided with the customary three furrows. The pollen grains of the poplars, on the other hand, which everybody agrees are closely related to the willows but which are entirely wind pollinated, are almost perfectly smooth, with no oil, with an extremely thin—almost fragmentary—outer coat, and no trace of furrows. Another example is found in the tansies and sage brushes. These two genera are very closely related. In fact the sage brushes may be regarded as a group of wind pollinated derivatives of the insect pollinated tansies. The pollen grains of the tansies are provided with a thick spine-covered outer coat like those of most Compositae and covered with sticky oil, while those of the sage brushes have a much thinner outer coat, scarcely any oil and with only occasionally the merest traces of spines. Still another example is found in the ragweed pollen grains. They are characterized by a rather thick exine which is provided with short conical spines and covered with a thin layer of oil and have three small slit-like furrows. One would naturally conclude from appearances that such a grain must be entomophilous. It does have some entomophilous characters, but, if compared with the pollen grains of their truly entomophilous relatives, these characters are seen to be very much suppressed. For example the pollen grain of the related sunflower has a much thicker exine which is provided with long stiletto-like spines, covered with an abundant layer of oil and provided with three broad and freely functional furrows. The spines and oil of the ragweed grains must be regarded as only vestiges, harping back to their entomophilous ancestors. In the pollen of the closely related cocklebur which appears to be older in anemophily these characters are more completely suppressed; the grains are almost smooth, with only a trace of oil and with furrows reduced to small pits which could be of no possible use in adjusting the grain to changes in volume. Such a function is rendered unnecessary by the thinness of the exine.

Such, then, is the result of anemophily. In most anemophilous plants both the reduction of their pollen grains and the simplification of their floral structures have been carried so far that we have scarcely any clue to their relationships. The grass family affords an example of this. Their pollen grains present a single pore, showing that these plants probably belong to the basic monocotyledonous stock but further than this their pollen grains tell us nothing. Other examples are the birch family, the walnut family and others of the wind-pollinated Amentiferae. Their pollen grains tell us that they belong to the basic dicotyle-

---

EXPLANATION OF PLATE II

Beginning at the top and following down to the bottom the grains are named and their diameters given in microns.

Top, left—Ginkgo, *Ginko biloba* L., 28.5 long, ventral view.

Top, center—Pepper, *Piper nigrum* L., 13 long, ventral view, above dry, below moist.

Top, right—Willow, *Solix purpurea* L., 20.5, polar view.

Second, left—Poplar, *Populus tremuloides* Michx., 28.5.

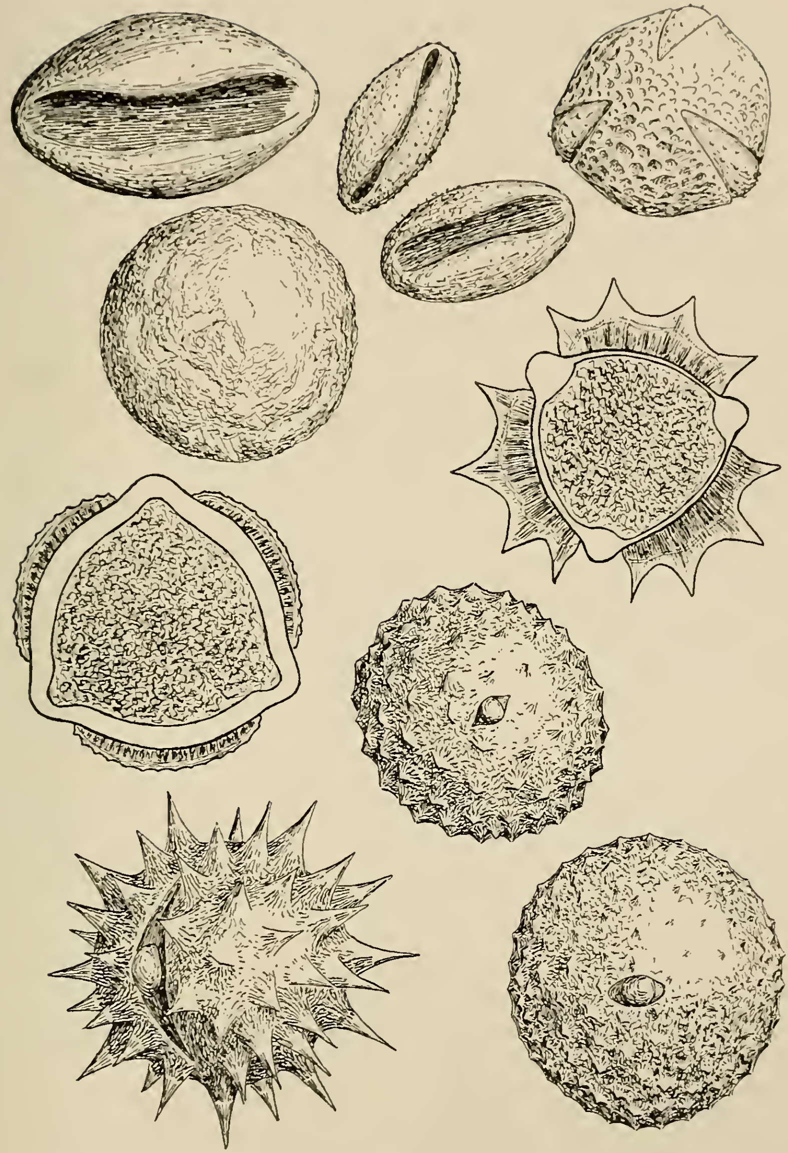
Second, right—Tansy, *Tanacetum vulgare* L., 26, polar view, optical section.

Third, left—Mugwort, *Artemesia vulgaris* L., 28. 5, polar view, optical section.

Third, right—Ragweed, *Ambrosia elatior* L., 17, side view

Bottom, left—Sunflower, *Helianthus annuus* L., 29, side view.

Bottom, right—Cocklebur, *Xanthium canadense* Mill., 27, side view.



WODEHOUSE: POLLEN Plate II

donous stock but nothing more. They are, however, enough different from each other so that we generally may easily recognize the family, often the genus and occasionally even the species of anemophilous pollen which is caught on atmospheric pollen slides. And this is always a great help to the student of hayfever.

Just which of the various kinds of pollen found in the air affect a hayfever patient may be determined by what is known to physicians as the skin test. The theory of the skin test is based on the fact that if a person is sensitive to any particular kind of pollen or other substance in such a way as to cause nasal or other respiratory symptoms the same sensitization extends to all parts of the body, so the customary way of performing the skin test is to make the tiniest possible nicks in the skin and apply to them drops of solutions extracted from the different kinds of pollen to be tested. When the right extract is applied the harmless-looking nick in the skin will immediately take on all the characteristics of a good lusty mosquito bite, including the swelling, itching and surrounding reddish irritation. The test belongs to that class of physiological reactions known as anaphylaxis which includes such phenomena as serum sickness and anaphylactic shock, and is characterized by an explosive violence out of all proportion to the quantity of the irritating material applied. For this reason the test should never be attemped except by the trained practitioner with standardized materials.

After the kinds of pollen in the air have been determined and which of these affect the patient, he has the choice of going elsewhere when the offensive pollens appear, or else of developing his tolerance beforehand. This is accomplished by administering a series of small but gradually increasing doses of extracts prepared from the pollens to which he is susceptible and likely to be exposed. In this the dosage must be carefully controlled. Too little is useless but too much is dangerous, so this also should be attempted only by a skilled physician.

Yonkers, N. Y.